Impact of aerosol definition on regional climate simulations over North Africa, Middle East and Europe

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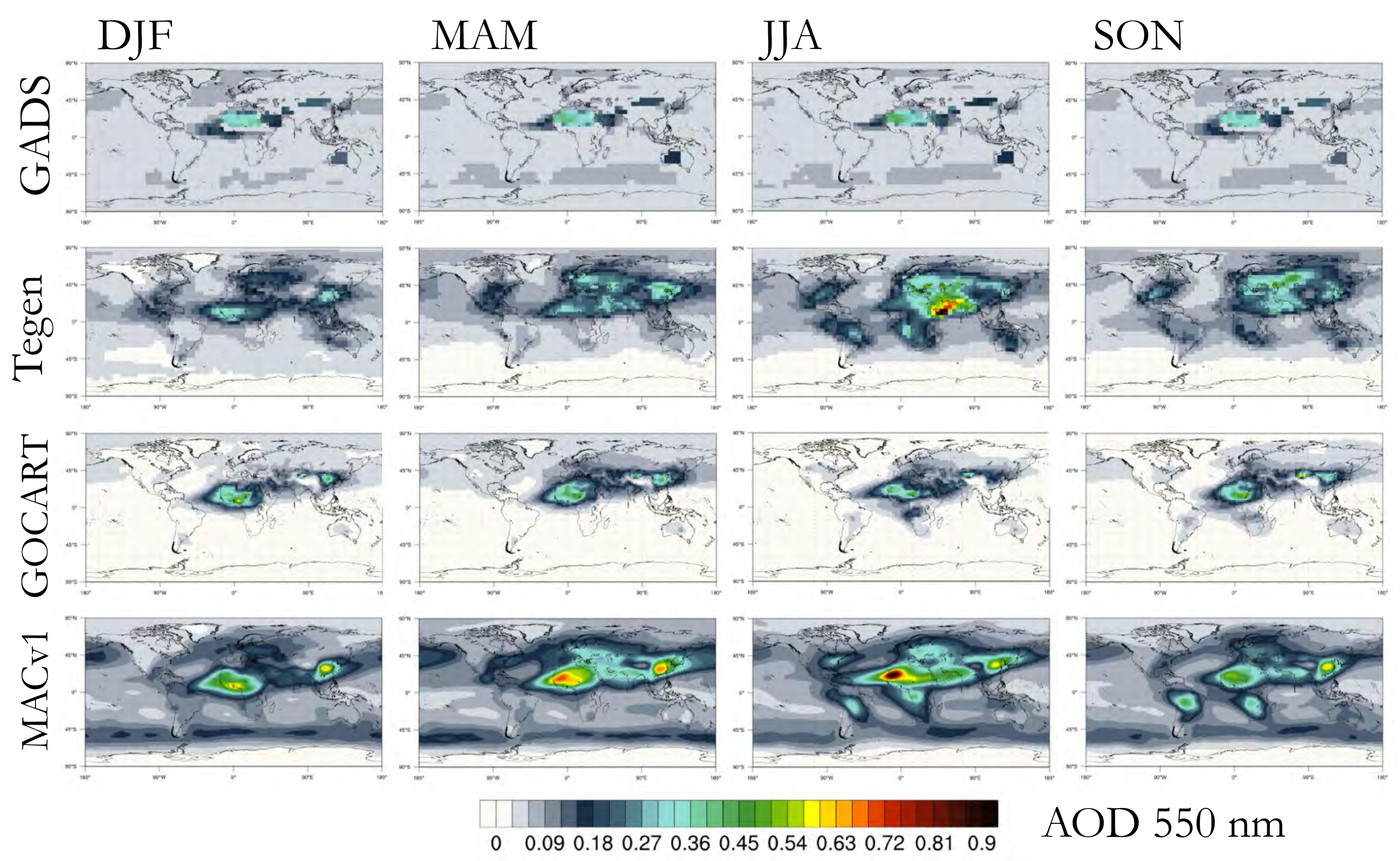
Most of the currently used Regional Climate Models (RCMs) deal with aerosol-radiation interactions using one of a limited number of aerosol climatologies, mainly Tanré-1984 (Tanré *et al.* 1984), GADS/OPAC (Hess *et al.*, 1998; Koepke *et al.* 1998) or Tegen-1997 (Tegen *et al.* 1997). These climatologies significantly differ on the spatio-temporal characterization of aerosol loads and optical properties (Hoggeneger and Vidale, 2005; Zubler *et al.* 2011), which influences the RCMs estimates of the radiative budget and, hence, other climatic variables.

This work analyses the **effect of aerosol climatologies on dynamic downscaling simulations** over the **North Africa, Middle East and Europe** (NAMEE) region, by means of the **NMMB/BSC-CTM model**. We focus on the effect of **spatio-temporal variability** and **optical properties**, by using and modifying the GADS/OPAC and GOCART datasets. An **online** approach for the simulation of **mineral dust - radiation interaction** is applied, allowing us to account for full dust-climate feedbacks.

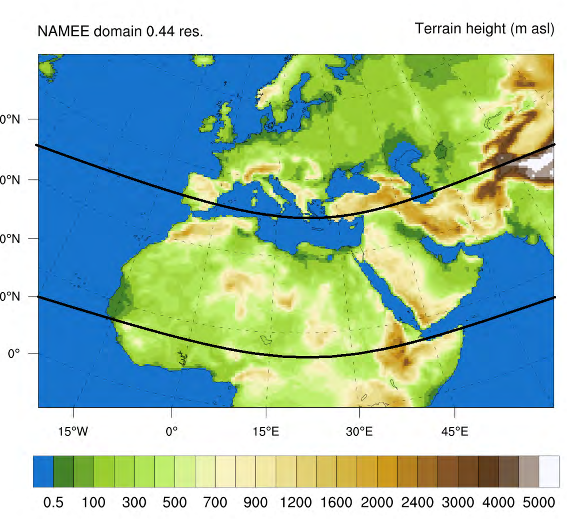
Aerosol climatologies intercomparison

Seasonal mean Aerosol Optical Depth (AOD) at 550 nm as defined in GADS/OPAC, Tegen-1997, GOCART and MACv1 (Kinne *et al.* 2006) aerosol climatologies



NMMB/BSC-CTM NAMEE

ECMWF ERA Interim (Dee *et al.* 2011) as driver
0.44° horizontal resolution
40 vertical layers up to 50 hPa



North Africa average values calculated for the highlighted area (-20W:55E, 10N:35N)

STUDIED CASES:

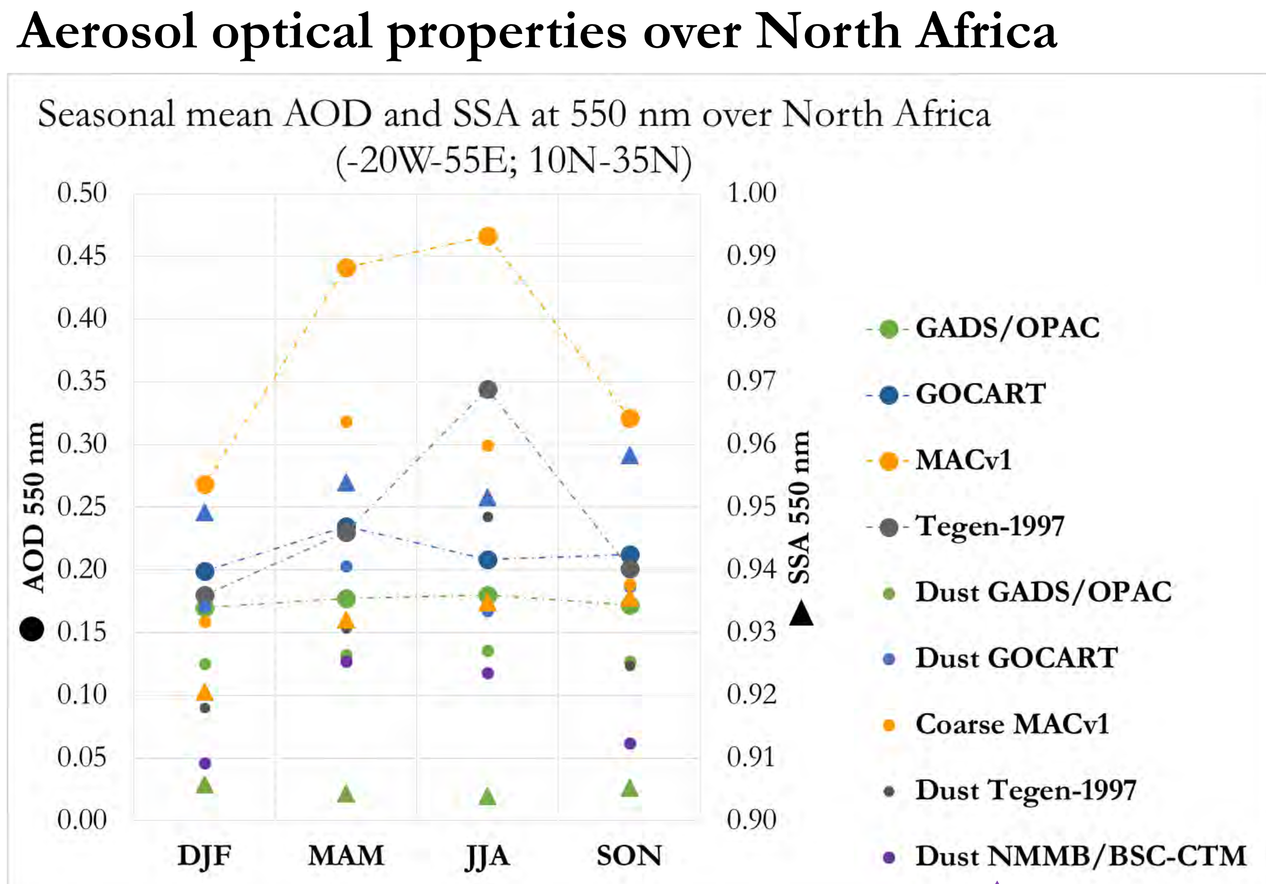
1994-2013 period

- No aerosols (NA)
- GADS/OPAC
- GOCART
- NMMB/BSC-CTM online dust (GOCART climatology for other aerosols)

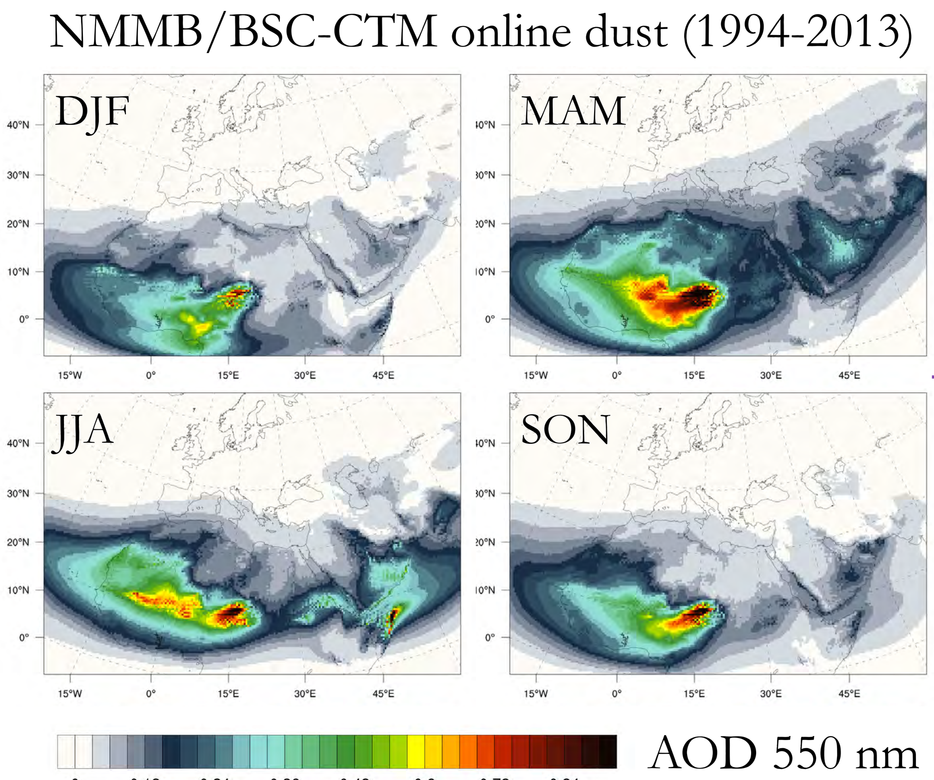
1994-1998 period

- GOCARTFIX (constant value for the aerosol load throughout the year)
- GOCART5 (aerosol load = 5 times GOCART values)
- SSAHIGH (GOCART aerosol distribution with SSA = 1)
- SSALOW (GOCART aerosol distribution with 20% lower SSA than originally)

Aerosol optical properties over North Africa



NMMB/BSC-CTM online dust (1994-2013)



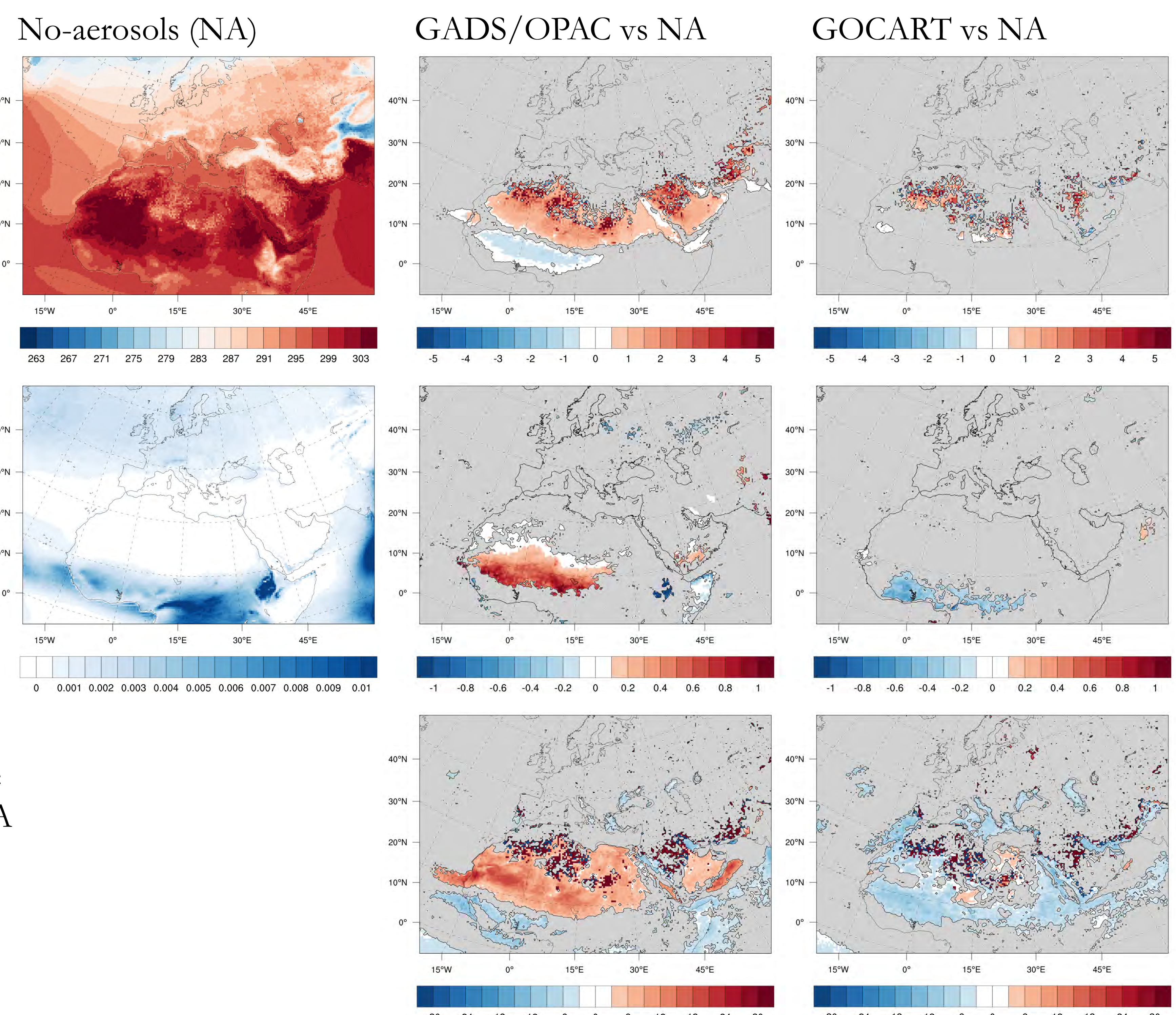
NMMB/BSC-CTM/ERAInterim 1994-2013

Difference in climatological means. Statistically non-significant differences (95% confidence level) are shaded

JJA mean Surface air temperature (K) 1994-2013

JJA mean Daily acc. precipitation (mm) 1994-2013

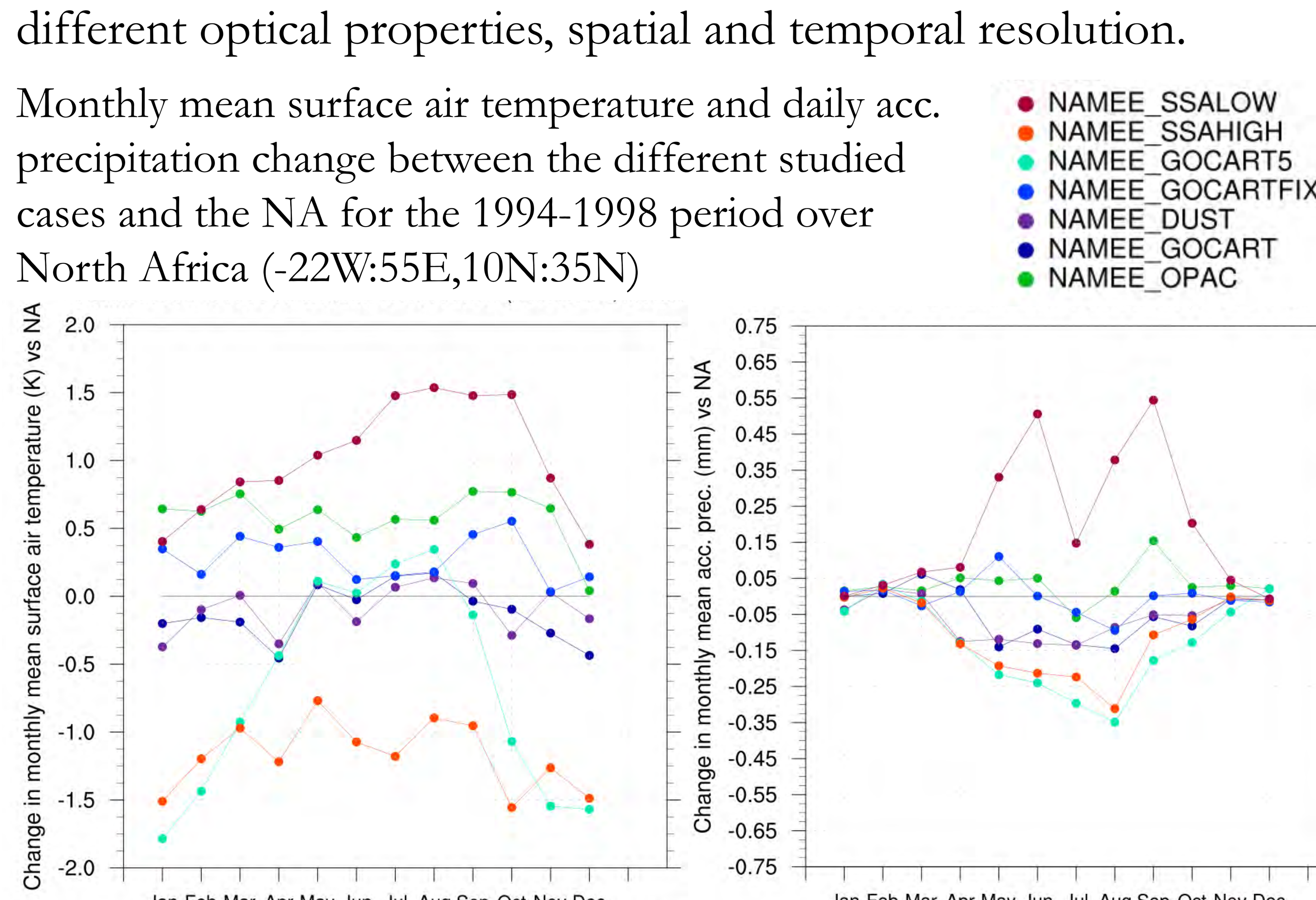
JJA mean All sky radiative anomaly at TOA (Wm^{-2}) 1994-2013



NMMB/BSC-CTM/ERAInterim 1994-1998

Impact of different aerosol configurations on the monthly mean temperature and precipitation over North Africa, including different optical properties, spatial and temporal resolution.

Monthly mean surface air temperature and daily acc. precipitation change between the different studied cases and the NA for the 1994-1998 period over North Africa (-22W:55E,10N:35N)



CONCLUSIONS

RCM projections are highly sensitive to the aerosols' definition, particularly over areas with large aerosol loads.

Small differences on single scattering albedo (around 7% larger in GOCART compared to GADS/OPAC) derive on different responses on seasonal mean surface air temperature and precipitation over North Africa. More absorbing aerosols (i.e. GADS/OPAC case) produce a warming over the North-African area, which involves a shift northward in the position of the ITCZ in summertime (increased precipitation amount between 10N and 20N and associated local cooling with respect to NA).

Aerosol monthly-varying fields increase the intra-annual variability of surface air temperature over North-Africa.

NMMB/BSC-CTM is able to reproduce the seasonal cycle of mineral dust in the long term (qualitatively). Fine changes in dust distribution only affect locally the surface air temperature and precipitation, being on average (North Africa and monthly scale) controlled by the absorbing/scattering properties of the aerosol, rather than the AOD.

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